

HELIUM

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Grade-A helium (99.995% or better purity) sales volumes in the United States by private industry and the Bureau of Land Management (BLM) were 84.2 million cubic meters (Mm³)² (3,028 million cubic feet) in 1998. Grade-A helium exports by private producers were 27.8 Mm³ (1,002 million cubic feet) for total sales of 113 Mm³ (4,030 million cubic feet) of U.S. helium, about a 4.7% increase from 1997. On January 1, 1998, the price for Grade-A helium, f.o.b. plant, and bulk liquid helium were \$1.983 per cubic meter (\$55 per 1,000 cubic feet) and \$2.524 per cubic meter (\$70 per thousand cubic feet), respectively, with additional costs for container services and rent.

Legislation and Government Programs

The Federal Helium Program was established to provide all Federal agencies with current and estimated future helium needs to carry out Government programs authorized and funded by the U.S. Congress. The BLM major helium customers were the U.S. Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the U.S. Department of Energy (DOE).

On October 9, 1996, the President signed the Helium Privatization Act of 1996 (Public Law 104-273). This legislation directed the Federal Helium Program to discontinue production and sale of refined helium by April 9, 1998. Key components of this legislation and applicable status updates are as follows:

- ! Cease production and sales of refined helium on or before April 9, 1998.
STATUS: All refining and sales were discontinued in March 1998.
- ! Dispose of all assets related to helium production, refining, and sales not later than 24 months after helium refinery closing.
STATUS: The 106 Historical Review should be completed by June 1, 1999, and reports should be completed by August 1999. The Phase 1 environmental site assessment was completed in early 1999, and reports should be

available by July 1, 1999. Property disposal actions are underway.

- ! Begin selling Federal crude helium reserves in excess of 600 million cubic feet on or before January 1, 2005, and complete sales by January 1, 2015. Crude helium sales (in kind) for helium that is sold to Federal agencies and their contractors by private companies began in January 1998. Open-market sale of the crude helium is dependent on a legislatively mandated study by the National Academy of Sciences (NAS) concerning the impact on national, scientific, and military interests.
STATUS: The NAS study is in progress, and a final report is expected by September 1, 1999.
- ! Continue operation of the helium storage field system, which includes the storage field and the crude helium pipeline used for storage and distribution of Government-owned and privately owned crude helium.
- ! Continue collection of helium royalties and fees from sales of helium extracted from gas produced from Federal lands.
- ! Continue helium resource evaluation and reserve tracking to monitor helium availability for essential Government programs.
- ! Complete land transfer to the Girl Scout Council.
STATUS: Historical/archeological reviews and environmental assessments are being carried out and are expected to be complete by January 1, 2000.

Production

In 1998, 16 companies operated 23 privately owned domestic helium plants, 16 of which and the BLM Exell plant extracted helium from natural gas. All but two extraction plants used cryogenic extraction processes. The volume of helium recovered from natural gas decreased by 7.3% compared with that of 1997, and total sales of U.S.-produced helium increased by 4.6% compared with that of 1997. All natural gas processed for helium recovery came from gasfields in Colorado, Kansas, Oklahoma, Texas, Utah, and Wyoming. During 1998, 11 private plants and the BLM Exell plant purified helium by using pressure swing adsorption technology. The BLM plant and nine privately owned plants that produced Grade-A helium also liquified helium. The plant operators and locations were as follows: Air Products and Chemicals, Inc., Hansford County, TX, and Liberal, KS; BOC Gases, Inc., Otis, KS;

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²All metric helium volumes herein reported are at 101.325 kilopascals absolute (14.696 pounds per square inch absolute) and 15°C (59°F). Helium volumes, reported in parentheses following metric units, are measured in cubic feet at 14.7 pounds per square inch absolute and 70°F—1000 cubic feet (14.7 pound per square inch absolute and 70°F) = 27.737 cubic meters (101.325 kilopascals absolute and 15°C) and 1 cubic meter (101.325 kilopascals and 15°C) = 36.053 cubic feet (14.7 pounds per square inch absolute and 70°F).

Coastal Corporation, Keyes, OK; Exxon Co., U.S.A.; Shute Creek, WY; GPM, Moore County, TX, and Hansford County, TX; Praxair, Inc., Bushton, KS and Ulysses, KS; Unocal, Moab, UT; UPR Fuels, Cheyenne Wells, CO; Nitrotec Energy Corporation, Cheyenne Wells, CO, and Chillicothe, TX.

The Nitrotec plants purify, but do not liquefy, helium (tables 1-3; figures 1-2).

Domestic production data for helium were developed by the BLM from records of its own operations, as well as from its own High Purity Helium Survey, a single voluntary canvass of private U.S. operations. Of the eight operations to which a survey request was sent, 100% responded, and those data plus data from BLM operations represent 100% of the total helium sales and recovery data shown in table 2.

Domestic helium measured reserves and indicated helium resources as of January 1, 1999, were estimated to be 11 Gm³ (395 billion cubic feet). The resources include measured reserves and indicated resources as estimated at 6.0 Gm³ (215 billion cubic feet) and 900 Mm³ (32 billion cubic feet), respectively, in natural gas with a minimum helium content of 0.3%. The measured reserves included nearly 960 Mm³ (34.8 billion cubic feet) stored by the BLM in the helium storage conservation system. Measured helium reserves in natural gas with helium content of less than 0.3% and greater than 0.05% were estimated to be 400 Mm³ (14 billion cubic feet). Indicated helium resources, a category of reserves slightly less certain than measured reserves, in natural gas with less than 0.3% helium, were estimated to be 3.7 Bm³ (134 billion cubic feet). The majority of these indicated reserves were derived from the Potential Gas Committee designation of unconfirmed/probable reserves (Curtis, 1999). Approximately 4.3 Bm³ (154 billion cubic feet), or 93%, of the domestic helium reserves under Federal ownership were in the Riley Ridge area and the Church Buttes Field in Wyoming and in the Cliffside Field in Texas.

Most of the domestic helium resources are in the Midcontinent and Rocky Mountain regions of the United States. The measured helium reserves were in approximately 102 gasfields in 11 States. About 93% of these reserves are contained in the Hugoton Field in Oklahoma, Kansas, and Texas; the Panoma Field in Kansas; the Keyes Field in Oklahoma; the Panhandle West and Cliffside Fields in Texas; and the Riley Ridge area in Wyoming. During 1998, the BLM analyzed 16 natural gas samples from 9 States in conjunction with its program to survey and identify possible new sources of helium.

Consumption

The major domestic end uses of helium were cryogenics (24.4%), pressurizing and purging (19.9%), welding (18.2%), and controlled atmospheres (16.0%). Minor uses included leak detection (5.6%), synthetic breathing mixtures (3.1%), and chromatography/lifting gas/heat transfer (total 12.8%) (figure 3). Estimated 1998 domestic consumption by end use was based on a 1995 end-use survey conducted by BLM Helium

Operations to determine the trends in helium usage. The information from the survey showed that welding, pressure/purging, lifting gas, leak detection, and inert atmosphere applications were the leading uses of gaseous helium. Cryogenics, specifically magnetic resonance imaging applications, dominated liquid helium use.

The BLM sales to Federal agencies and their contractors totaled 2.0 Mm³ (71.7 million cubic feet) in 1998. Direct helium purchases by DOD, DOE, and NASA constituted most of the BLM Grade-A helium sales. To replace the sales of refined helium that ceased in March 1998, "in kind crude helium sales" began in January 1998. New regulations, effective November 23, 1998, concerning in kind crude helium sales were published in 43 CFR Chapter II, Part 3195. These regulations require that helium refiners selling to Federal agencies and their contractors must buy an equivalent amount of crude helium from the BLM. In 1998, these sales were 3.8 Mm³ (136 million cubic feet) and were made by seven companies through contracts with the BLM. The regulations published in 43 CFR Chapter II, Part 3195, specifically eliminated sales that had previously been made through 30 CFR 601 and 30 CFR 602 which allowed BLM contractors to sell pure helium to Federal agencies and subsequently to purchase an equivalent amount of pure helium from the BLM. These discontinued regulations had made small volumes of helium readily available to Federal installations at lower freight charges by using the contractors' existing distribution systems.

Stocks

The volume of helium stored in the BLM helium conservation storage system, including the conservation pipeline network and the Cliffside Field, totaled 960 Mm³ (34.8 billion cubic feet) on December 31, 1998. The storage system contained crude helium purchased under contract by the BLM from 1962 to 1973 and privately owned helium, extracted by industry from natural gas supplying fuel markets, stored under contract. This privately owned helium is returned to the owners as needed for purification to supply private demand. During 1998, 32.5 Mm³ (1,175 million cubic feet) of private helium was delivered to the BLM's helium conservation system and 30.8 Mm³ (1,115 million cubic feet) was withdrawn for a net increase of 1.7 Mm³ (60 million cubic feet) of private helium in storage (table 4).

Transportation

All Grade-A helium sold by the BLM was shipped in modules (large gas cylinders), special railway tankcars, or highway tube semitrailers from either the Amarillo Helium Plant (a container filling facility only) or the Exell Helium Plant in Masterson, TX. Private producers and/or distributors shipped helium predominantly as a liquid in semitrailers. These semitrailers delivered the liquid helium to distribution centers where some of it was gasified and compressed into

trailers and small cylinders for delivery to end users. The remaining liquid helium was sold as bulk liquid or repackaged in dewars of various sizes for delivery.

Prices

The price charged for crude helium to private companies for sales to the Federal government and their contractors was \$1.694 per cubic meter (\$47 per thousand cubic feet) for fiscal year 1998 and will be \$1.767 per cubic meter (\$49 per thousand cubic feet) for fiscal year 1999.

Foreign Trade

In 1998, exports of Grade-A helium, all by private industry, decreased to 27.8 Mm³ (1.00 billion cubic feet) (table 3). About 58% of the U.S. helium exports went to Asia, with Japan receiving about 72% of the Asian export. About 20% of the exported helium was shipped to Europe; collectively, Belgium, France, Germany, and the United Kingdom, collectively, received 97% of the European exports. Other exports were as follows: North America, 9%; South America, 5%; Australia-New Zealand, 4%; Middle East, 2%; Africa, 2%; and less than 1% to Central America and the Caribbean. A small quantity (237,000 cubic meters) of helium was imported by the United States in 1998. Import tariffs on helium established on January 1, 1997, remained at the 3.7% rate for most favored nations and at the 25% for non-most-favored-nations.

World Review

Excluding the United States, world production capacity of helium was estimated to be 29 Mm³ (1,045 billion cubic feet). All known helium produced outside of the United States was extracted in Algeria, Poland, and Russia (table 5).

Outlook

The total market for U.S.-produced helium increased by 4.6% compared with that of 1997. From 1993 to 1998, the market growth rate was about 3.2%. Market growth rate for private industry helium in 1998 increased by 8% compared with that of 1997 and the market growth rate for private industry was near 4.6% per year for the five year period from 1993 to 1998.

In 1998, private industry supplied about 98.2% of the domestic demand, and the Federal Government supplied the remaining 1.8%. Helium exports decreased by 5.8% compared with that of 1997 and accounted for 24.8% of the U.S.-produced helium sales; private industry supplied all U.S.

helium exports. Expansion of the Asian helium market is expected to moderate owing to the uncertain economic condition in that region of the world. Competition from foreign helium producers will provide continued uncertainty in the strength of the U.S. exports to the global helium market. Helium sales in the private sector are expected to continue at a moderate growth rate of 5% during the next 3 years. Use of high-temperature superconductor materials in electric motor windings and increased fiber optics demands are expected to increase helium demand.

References Cited

Curtis, J. B. 1999, Comparison of estimates of recoverable natural gas resources in the United States—a report of the Potential Gas Committee, Colorado School of Mines.

SOURCES OF INFORMATION

U.S. Geological Survey Publications

Helium. Ch. in Mineral Commodity Summaries, Annual.³
Helium. Ch. in Minerals Yearbook, Annual.
Helium. Ch. in United States Mineral Resources, U.S. Geological Survey Professional Paper 820, 1973.

Other

Analyses of Natural Gases, 1917-85, U.S. Bureau of Mines Information Circular 9129, 1987.

Analyses of Natural Gases, 1986-90, U.S. Bureau of Mines Information Circular 9301, 1991.

Analyses of Natural Gases, 1991, U.S. Bureau of Mines Information Circular 9318, 1992.

Analyses of Natural Gases, 1992, U.S. Bureau of Mines Information Circular 9356, 1993.

Analyses of Natural Gases, 1993, U.S. Bureau of Mines Information Circular 9400, 1994.

Helium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

Helium Resources of the United States, 1991, U.S. Bureau of Mines Information Circular 9342, 1993.

Helium Resources of the United States, 1997, Bureau of Land Management, Technical Note 403, 1998.

Analyses of Natural Gases, 1996-97, Bureau of Land Management, Technical Note 404, 1998.

³Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
OWNERSHIP AND LOCATION OF HELIUM EXTRACTION PLANTS IN THE UNITED STATES IN 1998

Category and owner or operator	Location	Product purity
Government owned:		
Bureau of Land Management	Masterson, TX	Grade-A helium 1/ 2/
Private industry:		
Air Products and Chemicals, Inc.	Hansford County, TX	Do. 1/
Do.	Liberal, KS	Do. 1/
Amoco	Ulysses, KS	Crude helium 3/
BOC Gases, Inc.	Otis, KS	Grade-A helium 1/
CIG Company (a subsidiary of Coastal Corporation)	Keyes, OK	Do. 1/
Do.	Lakin, KS	Crude helium
Crescendo Resources	Sunray, TX	Do.
Exxon Co., U.S.A.	Shute Creek, WY	Crude and Grade-A helium 1/
GPM	Moore County, TX	Crude helium
Do.	Hansford County, TX	Do.
KN Energy	Bushton, KS	Do.
Do.	Scott City, KS	Do. 4/
National Helium Corp.	Liberal, KS	Do.
Nitrotec Energy Corporation	Cheyenne Wells, CO	Grade-A helium 5/
Do.	Chillicothe, TX	Do.
Pioneer Resources	Fain, TX	Crude helium
Do.	Satanta, KS	Do.
Praxair, Inc.	Bushton, KS	Grade-A helium 1/
Do.	Ulysses, KS	Do. 1/
Trident NGL	do.	Crude helium 6/
Unocal	Moab, UT	Crude and Grade-A helium 1/
UPR Fuels	Cheyenne Wells, CO	Do. 1/ 7/
Williams Field Services	Baker, OK	Crude helium

1/ Including liquefaction.

2/ Stopped production in March 1998.

3/ Began production in May 1998.

4/ Output is piped to Ulysses, KS, for purification.

5/ Began production in March 1999 (est). Plant relocated, all 1998 production in Burlington, Colorado.

6/ Stopped production in May 1998.

7/ Began production in October 1998.

TABLE 2
HELIUM RECOVERY IN THE UNITED STATES 1/ 2/

(Thousand cubic meters)

	1994	1995	1996	1997	1998
Crude helium:					
Bureau of Land Management (BLM) total storage	(7,200)	(7,600)	(7,230)	(6,130)	(900)
Private industry:					
Stored by BLM	38,800	36,100	36,700	36,700	33,000
Withdrawn	(19,500)	(23,200)	(21,200)	(21,300)	(31,400)
Total private industry storage	19,300	12,900	15,500	15,400	1,600
Total crude helium	12,100	5,300	8,270	9,270	700
Stored private helium withdrawn from storage and purified by the BLM for redelivery to industry	(610)	(69)	--	--	--
Grade-A helium:					
BLM sold	6,610	7,210	6,060	5,260	1,990
Private industry sold	93,800	88,900	88,600	102,000	110,000
Total sold	100,000	96,100	94,700	107,000	112,000
Total stored	11,500	5,230	8,270	9,270	700
Grand total recovery	112,000	101,000	103,000	116,000	112,000

1/ Negative numbers are enclosed in parenthesis () to denote net withdrawal from the BLM's underground storage facility, a partially depleted natural gas reservoir in Cliffside Field near Amarillo, TX.

2/ Data rounded to three significant digits; may not add to totals shown.

TABLE 3
TOTAL SALES OF GRADE-A HELIUM PRODUCED IN THE UNITED STATES 1/

(Million cubic meters)

Year	Volume		Total sales
	Domestic sales	Exports 2/	
1994	75.4	25.0	100
1995	68.4	27.7	96.1
1996	71.9	22.8	94.7
1997	77.4	29.5	107
1998	84.2	27.8	112

1/ Data rounded to 3 significant digits; may not add to totals shown.

2/ Source: Bureau of the Census.

TABLE 4
SUMMARY OF BUREAU OF LAND MANAGEMENT HELIUM CONSERVATION STORAGE SYSTEM OPERATIONS 1/2/
(Thousand cubic meters)

	1996	1997	1998
Helium in conservation storage system on January 1:			
Stored under BLM conservation program	870,000	863,000	857,000
Stored for private producers under contract	100,000	115,000	131,000
Total	970,000	978,000	988,000
Input to system:			
Net deliveries from BLM plants 3/	(7,230)	(6,130)	(900)
Stored for private producers under contract	36,700	36,700	33,000
Total	29,500	30,600	32,100
Redelivery of helium stored for private producers under contract 3/	(21,200)	(21,300)	(31,400)
Net addition to system	8,260	9,230	700
Helium in conservation storage system on December 31:			
Stored under BLM conservation program	863,000	857,000	856,000
Stored for private producers under contract	115,000	131,000	133,000
Total	978,000	988,000	989,000

1/ Crude helium is injected into or withdrawn from the BLM's underground storage facility, a partially depleted natural gas reservoir in Clifside Field near Amarillo, TX.

2/ Data rounded to three significant digits; may not add to totals shown.

3/ Numbers in parentheses () indicated net withdrawal from storage.

TABLE 5
WORLD GRADE-A HELIUM PRODUCTION
ANNUAL CAPACITY, DECEMBER 31, 1998

(Million cubic meters)

	Capacity
United States 1/	130
Rest of world e/	29
Total e/	159

e/ Estimated.

1/ Includes plant on standby as well as operating plants

FIGURE 1
HELIUM RECOVERY IN THE UNITED STATES

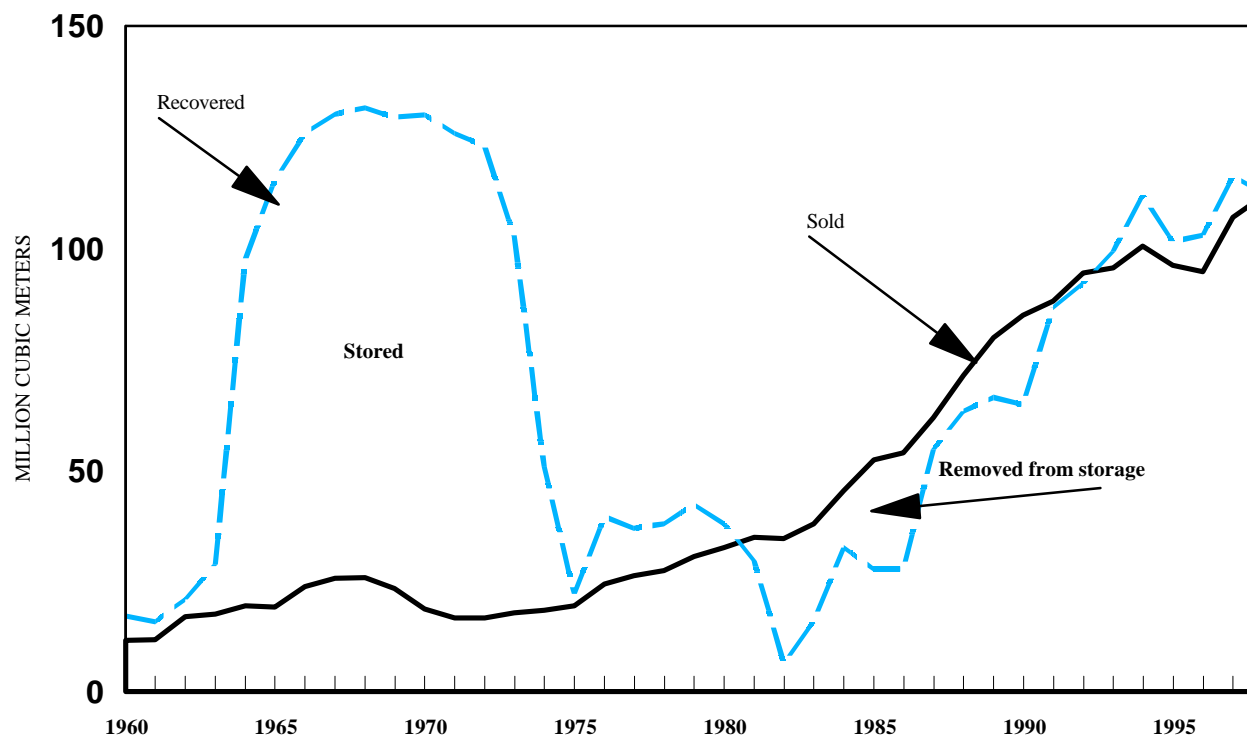


FIGURE 2
MAJOR U.S. HELIUM BEARING
NATURAL GAS FIELDS

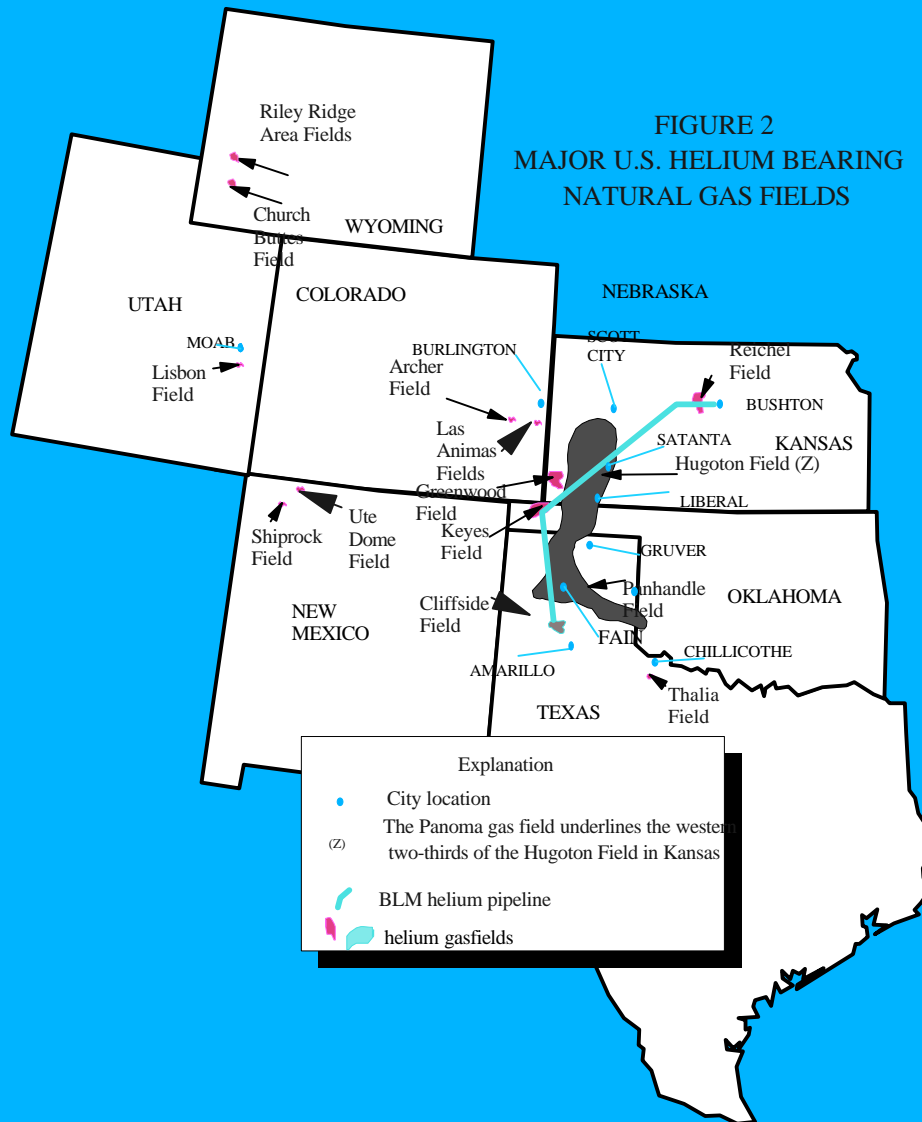
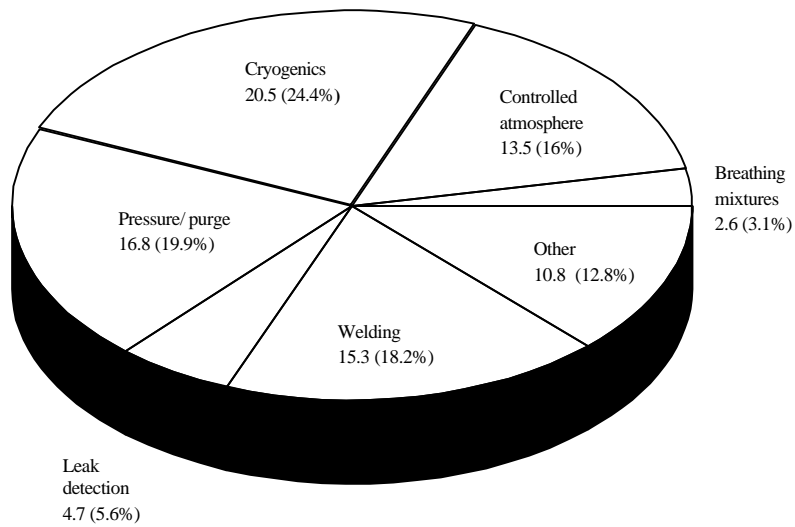


FIGURE 3
ESTIMATED HELIUM CONSUMPTION, BY END USE,
IN THE UNITED STATES IN 1998

(Million cubic meters)



Estimated total helium used
(84.2 million cubic meters)